Practical Breeding
Program Issues – Beef Industry

Kath Donoghue
Scientist
Animal Genetics and Breeding Unit
Overview of presentation

1. Structure of beef industry
   - Some characteristics
   - Role of different sectors (seedstock; cow-calf; grower/finisher; end-user)

2. Genetic improvement in the beef industry
   - Defining breeding objectives
   - Utilising available tools (eg EBVs; $Indexes; gene markers)
   - Breeding design (eg crossbreeding)

3. Future developments
Structure of the industry

Some characteristics of the beef industry:

- Many herds
- Many geographic locations
- Many breeds
- Regular inflow of genetics from outside herd

Impact amount & rate of genetic progress
Beef industry consists of four general sectors:

- Seedstock sector
- Cow-calf sector
- Grower/finisher sector
- End-user (processor sector)

Only seedstock & cow-calf sectors involved in genetic improvement
Seedstock sector

Core of genetic improvement:

- Create & supply superior genetics
- Foundation of genetic evaluation system (BREEDPLAN)
- Direction of breeding program for whole industry
- Communication

Use of artificial insemination (AI):

- Differs across breeds (eg Angus 42%; Hereford 19%)
- Much lower than dairy industry
Cow-calf sector

Main roles in genetic improvement:

- Identify & obtain superior genetics
- Implement effective mating program
- Market product to sectors further down supply chain
- Provide feedback to seedstock sector

Use of artificial insemination (AI):

- Less than 5% of herds
- Big opportunities in future
Grower/finisher sector

Grower/finisher:

- Value-added product
- **Buy** in animals to grow-out/finish (fatten) & sell
- Provide feedback to cow-calf (& seedstock) sectors

Not actively involved in genetic improvement but........

- Benefit from superior genetics
- Need to be aware of genetic information available
End-user sector

End-users:

- Feedlots, processors
- Little use of genetic information in past
- Unwillingness to pay premium for superior genetics???
- Provide critical feedback to ALL sectors

Not actively involved in genetic improvement but........

- Benefit from superior genetics
- Need to be aware of genetic information available
Key components of genetic improvement

1) Breeding objective
   - Determine goal of breeding program

2) Genetic evaluation
   - Describe genetic merit of selection candidates

3) Breeding program design
   - Make selection and mating decisions
   - Use all available tools (e.g., crossbreeding, AI, ET)
Defining breeding objectives

Critical component of genetic improvement:

- Determines genetic merit of future generations in all sectors

Breeding objective considerations should include:

- Production system of (commercial/grower/end-user) clients
- Traits of economic importance in client’s production system

BreedObject:

- Tool to assist in formalising breeding objectives
- Available on the internet (http://www.breedobject.com)

Breeding objectives should be revised on a regular basis!
Utilisation of available tools

Descriptors of genetic merit:

- EBVs (BREEDPLAN)
- $Indexes (BreedObject)
- Gene marker tests (GeneSTAR® marbling, tenderness & feed efficiency)

Reproductive tools:

- Embryo transfer (ET)
- Artificial insemination (AI)
BREEDPLAN

- Modern beef cattle genetic evaluation system
- Flexible and evolving system
- Genetic comparisons across herds, years
- Within breed (now some multi-breed tables)
- 20 Aust. breeds + several overseas clients
- Produces Estimated Breeding Values (EBV)
  – *tool to assist breeding of more profitable cattle*
BREEDPLAN Analysis

- performance records
e.g. weights, scans, carcass, joining records
- complete management data
- pedigree information
- Best Linear Unbiased Prediction (BLUP)
- one system (breed specific input files)
BREEDPLAN Model

• animal model with full pedigree
• multiple trait (all together)
  – 5 growth (+ maternal for BW, WWT)
  – 10 carcase (scans and abattoir)
  – 4 fertility
• Heritabilities and correlations (both + & -)
  – don’t need to know ..... all an animal’s EBVs
  – but important to measure all traits
    • find “curve benders” and allow selection for balance
BREEDPLAN Models (cont.)

- genetic groups (base animals)
  - time, overseas, and breeds
- statistical enhancements – SxH, HV
- incorporate overseas EPDs
  (currently under review to increase OZ emphasis)
- additional threshold model
  - calving ease (with BWT and GL)
  - temperament scores
Traits in BREEDPLAN

growth  carcass  reproduction
## Traits in BREEDPLAN

<table>
<thead>
<tr>
<th>growth</th>
<th>carcase</th>
<th>reproduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>birth wt</td>
<td>scan rib fat</td>
<td>gestation length</td>
</tr>
<tr>
<td>weaning wt</td>
<td>scan P8 fat</td>
<td>scrotal size</td>
</tr>
<tr>
<td>yearling wt</td>
<td>scan EMA</td>
<td>days to calving</td>
</tr>
<tr>
<td>final wt</td>
<td>scan IMF%</td>
<td>calving ease</td>
</tr>
<tr>
<td>mature cow wt</td>
<td>carcase wt</td>
<td>- direct</td>
</tr>
<tr>
<td>net feed intake</td>
<td>carcase EMA</td>
<td>- daughters</td>
</tr>
<tr>
<td></td>
<td>carcase rib fat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>carcase P8 fat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>retail yield %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IMF% (marbling)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>temperament</td>
</tr>
</tbody>
</table>
Hereford Animal Details

**COURALLIE WALLABY (AI)**

<table>
<thead>
<tr>
<th>Identifier</th>
<th>HH1W013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
</tr>
<tr>
<td>Tattoo</td>
<td>W013</td>
</tr>
<tr>
<td>Birth Date</td>
<td>17/03/2001</td>
</tr>
<tr>
<td>Calving Year</td>
<td>2001</td>
</tr>
<tr>
<td>Reg. Status</td>
<td>Registered</td>
</tr>
<tr>
<td>Status</td>
<td>Active</td>
</tr>
<tr>
<td>Sire</td>
<td>HH ADVANCE 885H (IMP)</td>
</tr>
<tr>
<td>Dam</td>
<td>COURALLIE DAFFODIL T170 (AI)</td>
</tr>
<tr>
<td>Breeder</td>
<td>COURALLIE HEREFORDS</td>
</tr>
<tr>
<td>Current Owner</td>
<td>DONOGHUE PAST CO</td>
</tr>
<tr>
<td>Society</td>
<td>AHS</td>
</tr>
<tr>
<td>Horn</td>
<td>Horned</td>
</tr>
<tr>
<td>Progeny</td>
<td>[View All] [View by Breed]</td>
</tr>
<tr>
<td>Pedigree</td>
<td>[View]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2005 AUTUMN GROUP BREEDPLAN EBVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trait</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>EBV</td>
</tr>
</tbody>
</table>

Breed Avg: EBVs for 2003 Born Calves

Traits Observed: 200WT, 400WT, SS, FAT, EMA, IMF

Statistics: Number of Herds: 2, Progeny Analysed: 17, Sex Progeny: 0, Carcass Progeny: 0, Number of Dirs: 0

Show Index Values
BreedObject

*Breeding objective & indexing software for the beef industry*
Profit focus for breeding

whole commercial market production system - *cow herd to slaughter*

Genealogy:

- **COW**: fertility, milk, survival, calving ease, feed intake, weight
- **CALF**: calving ease, growth, feed intake, growth rate, feed intake

**Genes**: Cow-calf, Grower, Finisher
Profit Drivers

**COW**
- calving ease
- weaning rate
- milk
- survival rate
- liveweight
- feed intake

**YOUNG ANIMAL**
- calving ease
- sale liveweight
- feed intake
- dressing %
- carcase meat %
- carcase fat depth
- carcase marbling
economic values

for the commercial production use targeted, over a planning horizon, & with discounting to present value

For change in a profit driver, assess:

change in returns
change in costs
change in feed cost

For other profit drivers unchanged

economic value

($ / trait unit)
Factors that can affect the importance of the profit drivers ... from one breeder or herd to another

breeding role
market
country
cow herd
management
view of future
Calculating the value of the profit drivers...

**Intended use of bulls (genes)**

**HERD MODEL** (with retained ownership)

$\text{value of changing each profit driver}$
(with others unchanged)

**Example:** Hereford Supermarket

<table>
<thead>
<tr>
<th>Economic Values</th>
<th>$ per unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Liveweight Dir.</td>
<td>0.583 $/Kg</td>
</tr>
<tr>
<td>Sale Liveweight Mat.</td>
<td>0.410 $/Kg</td>
</tr>
<tr>
<td>Dressing %</td>
<td>5.504 $/%</td>
</tr>
<tr>
<td>Saleable Meat %</td>
<td>4.428 $/%</td>
</tr>
<tr>
<td>Fat Depth (rump)</td>
<td>5.531 $/MM</td>
</tr>
<tr>
<td>Cow Weaning Rate</td>
<td>0.976 $/%</td>
</tr>
<tr>
<td>Marbling Score</td>
<td>0.000 $/scor</td>
</tr>
<tr>
<td>Cow Survival Rate</td>
<td>2.697 $/%</td>
</tr>
<tr>
<td>Cow Weight</td>
<td>-0.176 $/Kg</td>
</tr>
<tr>
<td>Calving Ease - dir.</td>
<td>1.800 $/%</td>
</tr>
<tr>
<td>Calving Ease - mat.</td>
<td>0.735 $/%</td>
</tr>
</tbody>
</table>
### Genetic Variation

#### Profit Drivers

<table>
<thead>
<tr>
<th>Genetic Std. Dev.</th>
<th>19.6 kg</th>
<th>8.8 kg</th>
<th>1.0 %</th>
<th>1.5 %</th>
<th>1.3 mm</th>
<th>9.7 %</th>
<th>n.a.</th>
<th>1.7 %</th>
<th>31.3 kg</th>
<th>7.9 %</th>
<th>7.9 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Liveweight Dir.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sale Liveweight Mat.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dressing %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saleable Meat %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat Depth (rump)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow Weaning Rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marbling Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow Survival Rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calving Ease - dir.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calving Ease - mat.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## % importance - how calculated

\[
REV = \text{economic value} \times \text{Genetic Std. Dev.}
\]

<table>
<thead>
<tr>
<th>Profit drivers</th>
<th>REV (relative econ. value)</th>
<th>% Profit driver importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Liveweight Dir.</td>
<td>11.4 $</td>
<td>15 %</td>
</tr>
<tr>
<td>Sale Liveweight Mat.</td>
<td>3.6 $</td>
<td>5 %</td>
</tr>
<tr>
<td>Dressing %</td>
<td>5.7 $</td>
<td>8 %</td>
</tr>
<tr>
<td>Saleable Meat %</td>
<td>6.6 $</td>
<td>9 %</td>
</tr>
<tr>
<td>Fat Depth (rump)</td>
<td>7.0 $</td>
<td>9 %</td>
</tr>
<tr>
<td>Cow Weaning Rate</td>
<td>9.5 $</td>
<td>13 %</td>
</tr>
<tr>
<td>Marbling Score</td>
<td>0.0 $</td>
<td>0 %</td>
</tr>
<tr>
<td>Cow Survival Rate</td>
<td>4.6 $</td>
<td>6 %</td>
</tr>
<tr>
<td>Cow Weight</td>
<td>-5.5 $</td>
<td>-7 %</td>
</tr>
<tr>
<td>Calving Ease - dir.</td>
<td>14.3 $</td>
<td>19 %</td>
</tr>
<tr>
<td>Calving Ease - mat.</td>
<td>5.8 $</td>
<td>8 %</td>
</tr>
</tbody>
</table>

\[
\left| \Sigma \right| = 74.0
\]
Importance of the profit drivers

Example: *Supermarket*

- Calving Ease - Direct: +19%
- Calving Ease - Maternal: +8%
- Cow Weight: -7%
- Cow Survival Rate: +6%
- Weaning Rate: +13%
- Sale Liveweight - Direct: +15%
- Sale Liveweight - Maternal: +5%
- Dressing %: +8%
- Meat Yield %: +9%
- Fat Depth (Rump): +9%
- Marbling Score: +0%
Importance of the profit drivers

Example: *Angus ‘B3’*

- Calving Ease - Direct: +12%
- Calving Ease - Maternal: +5%
- Cow Weight: -6%
- Cow Survival Rate: +5%
- Weaning Rate: +15%
- Sale Liveweight - Direct: +14%
- Sale Liveweight - Maternal: +3%
- Dressing %: +9%
- Meat Yield %: +11%
- Fat Depth (Rump): +0%
- Marbling Score: +20%
About $Indexes ... 

‘an EBV that’s targeted at the underlying market production system profit drivers’

- **overall** EBV, for economic merit (profit)
- use in both stud & commercial selection
- based on ‘BreedObject’ technology
Index process

Importance of PROFIT DRIVERS

Intended use of bulls (genes)

trait genetic r’ships

EBVs (numerous)

Index (numerous)

(economics & genetics)

(genetics & trait genetic r’ships)
From profit drivers to EBV emphases ...

$ values of the profit drivers

$ value emphasis for each EBV

Example: Supermarket

<table>
<thead>
<tr>
<th></th>
<th>E B V</th>
<th>Index Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calving Ease - dir.</td>
<td>2.079</td>
<td></td>
</tr>
<tr>
<td>Calving Ease - mat.</td>
<td>1.191</td>
<td></td>
</tr>
<tr>
<td>Birth Weight-direct</td>
<td>-0.662</td>
<td></td>
</tr>
<tr>
<td>200-day Milk</td>
<td>0.157</td>
<td></td>
</tr>
<tr>
<td>200-day Growth</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td>400-day Weight</td>
<td>0.047</td>
<td></td>
</tr>
<tr>
<td>600-day Weight</td>
<td>0.467</td>
<td></td>
</tr>
<tr>
<td>Days to Calving</td>
<td>-0.893</td>
<td></td>
</tr>
<tr>
<td>Scrotal Size</td>
<td>0.234</td>
<td></td>
</tr>
<tr>
<td>Carc. Fat Depth</td>
<td>3.074</td>
<td></td>
</tr>
<tr>
<td>Carc. Eye Muscle Area</td>
<td>0.589</td>
<td></td>
</tr>
<tr>
<td>Carc. Retail Beef Yld%</td>
<td>3.451</td>
<td></td>
</tr>
<tr>
<td>Mature Cow Weight</td>
<td>-0.066</td>
<td></td>
</tr>
</tbody>
</table>

$ per unit

multiply & sum to give $Index value
and for illustration purposes

<table>
<thead>
<tr>
<th>Measure</th>
<th>% Change</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calving Ease - Direct</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>Calving Ease - Maternal</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Birth Weight</td>
<td>-3%</td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>200-day Weight</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>400-day Weight</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>600-day Weight</td>
<td></td>
<td>16%</td>
</tr>
<tr>
<td>Days to Calving</td>
<td>-9%</td>
<td></td>
</tr>
<tr>
<td>Scrotal Size</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>P8 Fat Depth</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Eye Muscle Area</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Retail Beef Yield %</td>
<td></td>
<td>11%</td>
</tr>
<tr>
<td>Mature Cow Weight</td>
<td>-4%</td>
<td></td>
</tr>
<tr>
<td>$ per unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ per standard amount of units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>($ &amp; expressed as %)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2005 AUTUMN GROUP BREEDPLAN EBVS

EBV  
Calv. Ease  
Calv. Direct  
Calv. Ease Dtr.  
Gest. Len. (days)  
Birth Wt. (kg)  
200 Day Wt. (kg)  
400 Day Wt. (kg)  
600 Day Wt. (kg)  
Mat. Wt. (kg)  
Mat. Corr. Wt. (kg)  
Milk (kg)  
Sorrel Size (cm)  
Days to Calv.  
Carcass Wt. (kg)  
Eye Muscle Area (sq.cm)  
Rib Fat (mm)  
Rump Fat (mm)  
Retail Beef Yield (%)  
IMF %  
Net Feed Intake (kg/day)  

Acc  
84%  
72%  
98%  
97%  
97%  
96%  
92%  
93%  
82%  
79%  
89%  
89%  
87%  
83%  
59%

Breed Avg. EBVs for 2003 Born Calves (Click for Percentiles)

EBV  
-0.7  
+0.1  
-0.1  
+4.1  
+21  
+34  
+49  
+49  
+8  
+0.9  
-0.9  
+28  
+18  
+0.2  
+0.2  
+0.4  
0.0  
+0.04

Statistics: Number of Herds: 40, Progeny Analysed: 350, Scan Progeny: 141, Carcass Progeny: 0, Number of Dtr's: 96

Hide Index Values

<table>
<thead>
<tr>
<th>Selection Index Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Target</td>
</tr>
<tr>
<td>Supermarket</td>
</tr>
<tr>
<td>Hereford Prime</td>
</tr>
<tr>
<td>Short Fed (100-150 Days)</td>
</tr>
<tr>
<td>Long Fed Export</td>
</tr>
<tr>
<td>E U Index</td>
</tr>
</tbody>
</table>

Email worldgenetics@optusnet.com.au  
Homepage www.pollhereford.com.au

World Genetic Sale Notes
$Indexes widely available ...$

<table>
<thead>
<tr>
<th>Australia</th>
<th>Argentina</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Angus</td>
<td>• Argentine Angus</td>
</tr>
<tr>
<td>• Brahman</td>
<td></td>
</tr>
<tr>
<td>• Charolais</td>
<td></td>
</tr>
<tr>
<td>• Heref. &amp; Poll Herf.</td>
<td></td>
</tr>
<tr>
<td>• Limousin</td>
<td></td>
</tr>
<tr>
<td>• Murray Grey</td>
<td></td>
</tr>
<tr>
<td>• Santa Gertrudis</td>
<td></td>
</tr>
<tr>
<td>• Shorthorn</td>
<td></td>
</tr>
<tr>
<td>• Simmental</td>
<td></td>
</tr>
<tr>
<td>• AACo Composite</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>New Zealand</th>
<th>United Kingdom</th>
</tr>
</thead>
<tbody>
<tr>
<td>• NZ Angus</td>
<td>• UK Angus</td>
</tr>
<tr>
<td>• NZ Hereford</td>
<td>• UK Belgian Blue</td>
</tr>
<tr>
<td></td>
<td>• UK Simmental</td>
</tr>
<tr>
<td></td>
<td>• UK South Devon</td>
</tr>
</tbody>
</table>
Gene markers

Several tests currently available:

- GeneSTAR® marbling, tenderness & feed efficiency
- Igenity TenderGENE™

Reported separately to other descriptions of genetic merit

- Mainly used as marketing tool to date

Likely that more tests will become available

- Imperative that marker information is incorporated into EBVs
# Angus Animal Details

**BALD BLAIR HIGHMARK Z58 (AI) (TNC)**

<table>
<thead>
<tr>
<th>Identifier:</th>
<th>NBBZ58</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex:</td>
<td>Male</td>
</tr>
<tr>
<td>Tattoo:</td>
<td>BB Z58 (T) (Both Ears)</td>
</tr>
<tr>
<td>Birth Date:</td>
<td>20/07/2004</td>
</tr>
<tr>
<td>Calving Year:</td>
<td>2004</td>
</tr>
</tbody>
</table>

| Status:     | Active |
| Registration Status: | HBR |
| Colour:     | Tested non-carrier |
| **GeneStar® Marbling:** | Tested Marbling (M1-0, M2-1) Total of 1 favourable form of the genes. |
| **GeneStar® Tenderness:** | Tested Tenderness (T1-2, T2-2) Total of 4 favourable forms of the genes. |

- **Sire:** [GARDENS HIGHMARK](#)
- **Dam:** [BALD BLAIR W4 (AI)](#)
- **Breeder:** [BALD BLAIR PASTORAL CO](#)
- **Current Owner:** [BALD BLAIR PASTORAL CO](#)
- **DNA #:** 6642607
- **Progeny:** [View All](#) [View by Herd](#)
- **Pedigree:** [View](#)
- **EBV Graph:** [View](#)

* *Semen Available* *

**Angus Young Sire Program 2006**
Gene Marker Results

Gene Marker results are displayed on the web in two parts - a gene marker code and a test result.

1. Gene marker code
   - M1 - GeneStar Marbling 1
   - M2 - GeneStar Marbling 2
   - M3 - GeneStar Marbling 3
   - T1 - GeneStar Tenderness 1
   - T2 - GeneStar Tenderness 2
   - T3 - GeneStar Tenderness 3
   - T4 - GeneStar Tenderness 4

2. Test result
   - 0 indicates the animal carries zero copies of the favourable form of the gene.
   - 1 indicates the animal carries one copy of the favourable form of the gene.
   - 2 indicates the animal carries two copies of the favourable form of the gene.

For example, M3-2 indicates a GeneStar marbling 3 test with a result of 2 favourable forms of the gene.

Most animals listed with a gene marker result have had their DNA tested and this is described in the result line – for example: “Tested Tenderness (T1-2, T2-1)”.

However, some animals may have a “Derived” result because both parents have been tested and their specific results enable us to predict the gene forms of their progeny (see Predicting Progeny below). In many cases, however, it is not possible to predict the gene forms of the progeny even when both parents have been tested.

Click on the [GeneStar] logo for more information on their DNA markers and other commercial products.

Gene Markers
Breeding program design

Decide upon best strategies to reach breeding objectives:
- Decide who will become parents (selection decisions)
- Which bull to join to which cow? (mating decisions)

Total Genetic Resource Management (TGRM™):
- Tool to aid in selection and mating decisions
- Maximises genetic gain while minimising inbreeding
- Constraints can be included (eg sire usage, trait levels, costs)

Other design considerations:
- Can crossbreeding be used?
Future developments

- Inclusion of gene marker information in BREEDPLAN
- Multi-breed EBVs
- International genetic evaluations
- Availability of genetic benchmarking software